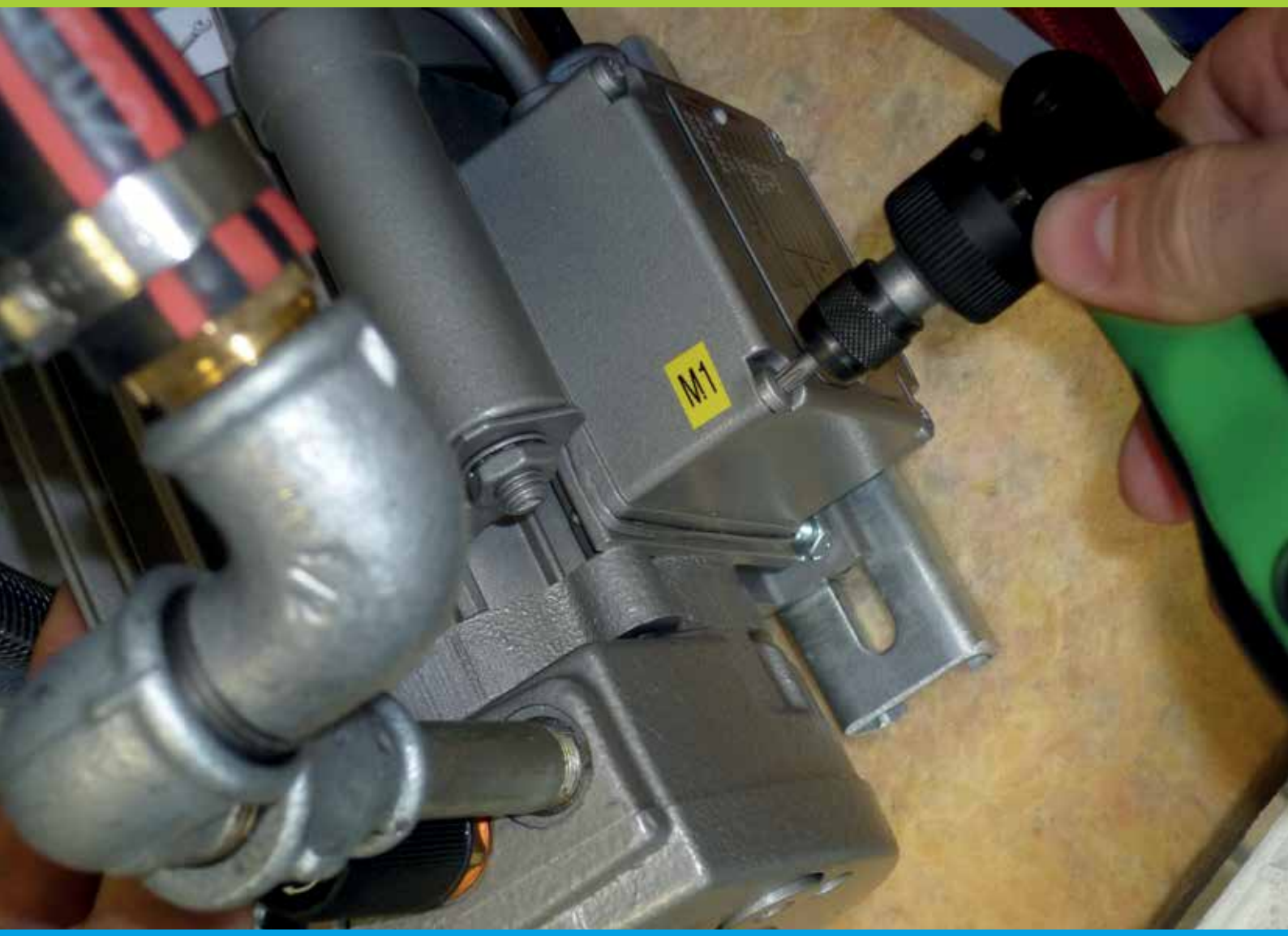
KLARO Maintenance Manual

We provide clear water



No mechanics
in the wastewater

No pumps
in the wastewater

No electrical parts
in the wastewater

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The KLARO Maintenance Manual!

1. Introduction

As a result of the robust wastewater treatment system and with proper operation, the KLARO wastewater treatment plant achieves optimal cleaning or clarification performance and long service life. It is necessary to check and maintain the plant regularly for proper operation.

The requirements and regulations for operation and maintenance are not uniform in the EU, but are governed and specified by each country independently.
In Germany, these requirements are governed and specified by the German Institute for Building Technology (DIBt).

They include self-checks and self-tests by the operator of the system as well as maintenance work by a specialist agency.

The self-checks and self-tests are described precisely in the logbook that is supplied along with every KLARO plant. The tasks of the maintenance specialist are meant to be explained here in detail. **This manual is to be considered as a recommendation.** It is closely in line with the maintenance rules and regulations of the DIBt and is based on more than ten years of practical experience that we have with the KLARO SBR technology.

Before we begin, what we particularly recommend to you is the following:

- document and record every maintenance with the help of the KLARO maintenance report (enclosure)
- carry out the work steps in the sequence in which they are listed in this manual (and in the maintenance report)
- to note down the serial number of the switch cabinet for any queries (is embossed on the nameplate in or fixed on the cabinet)

2. Safety instructions

While doing maintenance work on wastewater treatment plants, special precautionary measures need to be adopted since there may be viruses, pathogenic germs and worm eggs in the wastewater and on all surfaces that come into contact with wastewater. Inadequate or improper hygiene measures may lead to diseases (prevention of direct contact with wastewater and surfaces coming into contact with it).

The precautionary measures include:

- Wearing protective gear or safety clothing.
- Wearing hygienic hand gloves.

Wash and sterilise hands after they come into contact with wastewater.

- Vaccination for tetanus and hepatitis B.
- Consulting a doctor if wastewater has been swallowed.
- Entry into the plant by any person must be safeguarded by another person, since you need to reckon with harmful gases within the plant.
- Do not drink or eat while working.

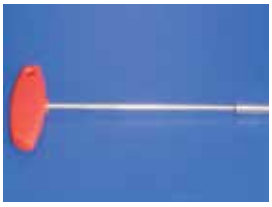
3. Maintenance accessories

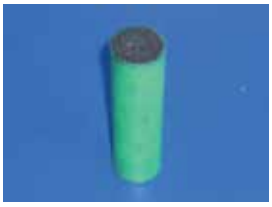
We have compiled a list of equipment, tools and spare parts that you should keep in order to be able to carry out maintenance professionally.

Maintenance accessories		Characteristics		Figure
Sludge pipette		• Determining the sludge level in the pre-clarification / sludge storage • DN40; 2 m + 1 m		
Buckets + telescopic extraction stick		• Withdrawal of bailed samples from the plant outlet from the integrated sampling facility and sludge samples (SV_{30}) from the SBR tank; • Plastic cup, 500 ml, • Telescopic rod, 1.0 – 3.0 m		

Measuring cylinder		• Determining the proportion by volume of the sludge (SV_{30}) • 1,000 ml, Ø 65 mm • Plastic or glass cylinder, graduated and completely transparent		
Imhoff funnel + holding frame		• Determining the substances that can be deposited (SS_{120}) • Glass funnel with division • 1,000 ml		
Measuring cup		• Determination of odour, coloration and turbidity • Glass cup with divisions and spout, 1,000 ml		
Sampling bottles + refrigeration box		• Sealable wide-neck bottles made of HDPE • For laboratory analyses • 1,000 ml for BOD_5 and SS_{120} • 500 ml for COD, N, P (transferred with 2 ml H_2SO_4)		
COD cuvettes		• Reagent cuvettes with chemicals for photometric COD measurement		
COD photometer		• Analysis of the COD value		
Safety glasses		• Eye protection when handling dangerous chemicals		
Oxygen measuring instrument, HACH LANGE HQ30d with sensor LDO101		• Measurement of dissolved oxygen [mg/l] in the activation tank and sampling; combined with temperature measurement [°C]		

Ammonium test strips		• Measurement of ammonium • Assessing whether the aeration is enough • Measuring range: 0 to 400 mg/l		
Nitrate / nitrite test strips		• Measurement of nitrate • Measuring range: 0 to 500 mg/l • Measurement of nitrite • Measuring range: 0 to 80 mg/l		
Phosphate test strips		• Measurement of total phosphate • Measuring range: 0 to 80 mg/l		
pH measurement strips		• Determining the pH value • 100 pieces • Measuring range: pH 4.5 - 10		
Hygiene hand gloves		• Protecting the hands from germs		
Sterilisation agent		• Protecting the hands from germs		
Manhole cover remover		• Removal of shaft covers made of concrete / cast iron		
Socket wrench		• Socket wrench, 17 mm, for opening small shaft covers made of PE		

Tape measure		• Determination of the sludge level height and water levels		
Cabinet key		• Opening all KLARO switching cabinets for indoor and outdoor installation		
Screwdriver		• Philips (slotted) screwdriver for dismantling the controller (outdoor cabinets) • Blade length: at least 14 cm		
Socket wrench		• Socket wrench for fastening hose clamps • 7 mm		
SD card		• Reading from controller (KLplus controller)		
Hose clamps		• Fastening hose pipes • 13 / 19 mm		
Interface cable		• Reading from the controller (ZK, ZKplus and KLbasic controllers)		
Multimeter		• Measuring capacitance, voltage, current and conductance		

Smoke cartridge		• Testing the bleeding of the plant		
Work gloves		• Protecting the hands while working on the plant		
Battery		• Replacement batteries for the ZK and ZKplus controllers • 9V		
Controllers		• Spare controllers (KLbasic and KLplus) including the connection cables		
Solenoid valve		• Spare coil with armature and spring • with a straight stem from 07/2002 to 05/2006 • with conical stem from 06/2006		
Air filter for the Nitto compressor		• Replacement of clogged air filters of a piston (or reciprocating) compressor, NITTO • different sets for LA60/80, LA120 and LA200		
Micro-fuses		• 2 A (slow speed), 8 A (medium speed)		
Disc aerator		• Replacement of defective disc aerators		

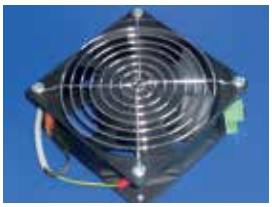
Cooling fan		• As a spare for cabinets with a rotary slide compressor or to retrofit cabinets with reciprocating compressors		
Grommets		• As replacement if grommets break off • Angled or straight		
Sealing tape		• In order to reseal hose connections and threads		

Table 1: Maintenance accessories

4. Maintenance work in the plant

4.1 Visual impression

Figure 1: Visual inspection of the tank

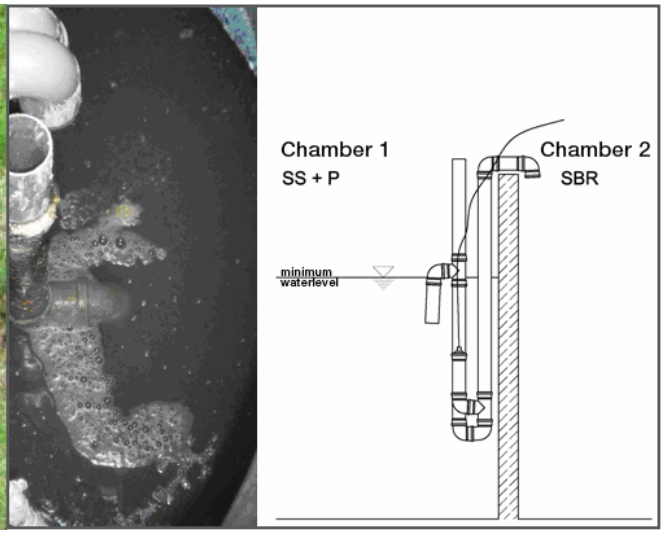


Figure 2: Minimum water level reached – the pump cannot be lowered any more

After opening the shaft manhole cover, you first obtain an overview of the visual impression of the KLARO plant.
You need to take decisions regarding:

- the general accessibility to the plant

→ Shaft manhole cover can be reached easily / not delivered

- the condition of the shaft manhole cover

→ Breakages, cracks, functionality of the child lock for PE covers…

- the condition of the feed pipes and drain pipes

→ Any signs of clogging

- the completeness and proper arrangement of the components installed

→ Aeration equipment, air-lift pump, air hose pipes and sampling

- the water levels of the individual chambers

→ Any signs of overflow in the chambers, hydraulic overload and problems with the air-lift pumps

- possible formation of floating sludge in the aeration chamber

– Surfactant foam:

solid, white foam, that remains stable when touched → Indication of the use of excessive detergent of washing agent

– Egg-white foam:

greyish foam, which collapses immediately when touched

→ An indication that there is biology in the build-up; often observed during the start-up phase.

- Signs of grease deposits, especially in case of restaurants

→ Grease separator overloaded or disposal is due

- the aeration and bleeding of the plant

→ via the building roof, shaft manhole cover or other aeration equipment

- the leak-tightness of the tank externally

→ Ingress of drainage water and high water levels; any signs of leakage if the level falls below the „minimum water level“

- Any signs of possible corrosion damage

→ particularly in the case of concrete tanks; accompanied in most cases with technical problems and lack of aeration and bleeding.

4.2. Analysis of wastewater and sludge

4.2.1 Drawing samples from the plant outlet for laboratory analyses

A random sample of the discharge from the plant is withdrawn for subsequent laboratory analyses. For this purpose, wastewater is carefully withdrawn with the help of a bucket from the integrated sampling vessel (not the SBR chamber!). While doing so, do not touch the walls of the vessel for drawing samples, since otherwise deposits come loose and worsen the sample disproportionately.

The random sample is filled carefully into the sealable sample bottle. There are different sample bottles depending on the laboratory and the parameters to be analysed.

- To determine the quantity of BOD_5 the bottle must be filled completely and without any bubbles as far as possible. To do this, tap on the filled and open bottle, so that the air bubbles get released from the edge of the bottle. Fill up the sample bottle once again until it overflows. Close the cap at this stage.
- For the determination of COD, N and P compounds, often bottles are used that already contain sulphuric acid (H_2SO_4). As a result, all decomposition processes cease and there is no falsification in the analysis resulting from the period of transportation to the laboratory.
- To determine the quantity of SS, about 0.5 litres of the random sample must be filtered and the filter residue must be weighed. In general, glass fibre filters or paper filters having pore widths of 0.3 to 1 µm are used for the filtration. This is why the same random sample may be used for determining the quantity of BOD_5. No separate sample bottle is required for this purpose.
- An exact quantity of 1.0 litre of wastewater is needed to determine the quantity of SS_{120}. This is why we recommend that you fill an additional random sample in another sample bottle for the exact determination of the substances that can get deposited. The random sample must be removed carefully from the bottle and stored under refrigeration until the analysis is conducted.

Figure 3: Withdrawing a random sample from the sampling vessel (black) using a bucket

Figure 4: Different sample bottles - Filling the random sample

Figure 5: Filling the sample

The sample bottles must be labelled in a comprehensible manner (Name / Date / Place).
Finally, the samples must be kept under refrigeration and stored in a dark place. A refrigeration box with a cold pack is ideal for this purpose. The samples should be brought to the laboratory as soon as possible since the composition may change with time.

The parameters with respect to which the samples should be analysed depend on the local requirements. The enclosure (or appendix) contains an overview of typical wastewater parameters and values, which are meant to assist you with the interpretation of the measured values.

4.2.2 Determining the substances that can be deposited (SS_{120})

The substances that may get deposited (SS_{120}) contained in the random sample, indicate the proportion of the solid content and include undissolved contaminants that may get deposited. The quantity of substances that may get deposited is determined in an Imhoff funnel (coneshaped glass). The Imhoff funnel must be placed upright in a frame for this purpose. The random sample is filled up to the 1,000 ml mark in the Imhoff funnel. The quantity of substances that may get deposited must be determined by reading the volume of substance at the tip of the funnel after a standing time of 2 hours.

Since solid substances get deposited on the slanted wall of the funnel, it is turned to and fro with a jerk 15 minutes prior to the completion of the standing time.

The quantity of the substances that may get deposited should not be more than 0.3 ml/l.

Since the determination of the substances that may get deposited takes 2 hours, we suggest that this measurement should not be carried out at site but in your own factory or laboratory. Until then, the sample must be kept under refrigeration.

Figure 6: Determining the substances that may get deposited in the Imhoff funnel

4.2.3 Assessing the odour, coloration and turbidity

Traditional property parameters of a wastewater sample are the odour, coloration and turbidity. The assessment of these semi-qualitative parameters reflects an excellent method of recording the condition of the treatment or cleaning performance of a wastewater treatment plant, without using measuring instruments.

It is best to evaluate the parameters immediately after withdrawing the random sample.

Odour

For the odour test, the measuring cup must be shaken with the sample filled. The type of the odour is differentiated subsequently (none, weak, strong or intense). The sample should have a neutral or earthy smell. If it smells of moulds or has a foul or sanious smell, the cleaning power of the wastewater treatment plant is faulty (e.g. on account of inadequate aeration).

Coloration

To assess the coloration, the colour strength and the shade of the colour are viewed against a white background and evaluated. The random sample should be clear to yellowish. A brown or grey coloration indicates inadequate cleaning or treatment.

Turbidity

Turbidity means the weakening of radiation passing through the sample. Turbidity is caused by suspended solids. To assess the turbidity, the random sample must be held in a measuring cup against sunlight and the weakening of the light radiation needs to be evaluated. If there are no suspended solids in the random sample, the sample has no turbidity. If, on the contrary, there are plenty of suspended solids in the random sample, it becomes highly turbid. Intense turbidity or a large amount of suspended solids are a sign of sludge output.

Figure 7: Random sample in a measuring cup for assessing the odour, coloration and turbidity

4.2.4 Measuring the water temperature

A scoop thermometer must be used for measuring the temperature. This must be held for 1-2 minutes in the random sample. Since the temperature is also measured with the oxygen measuring instrument, the scoop thermometer may be dispensed with.

4.2.5 Determining the pH-value

The pH-value is the easiest to measure with special test strips. You only need to immerse the test or measurement strip in the random sample. As soon as the test strip has been dipped in the sample, it takes up a certain colour. This colour now needs to be compared with the colour scale.
There are two types of measuring or test strips (universal and special test strips). The universal test strip can measure pH-values in the range between 1 and 12. The special test strip measures the value in a smaller range (e.g. pH 5 - 8) and has greater accuracy.

In addition, measuring instruments are available, which measure the pH-value in multiples of 0.1 pH after calibration. The pH-value should lie in a weakly alkaline range between 6.5 and 8.0.

Figure 8: Determining the pH-value using measurement or test strips

4.3 Analysis in the SBR chamber (aeration tank)

Apart from removing a random sample, direct analyses also need to be carried out in the activation tank.

- Proportion of sludge by volume
- Assessment of the aeration pattern
- Oxygen concentration

For this purpose, the aeration of the activation tank must be active or switched on in manual operation mode (Valve 2).

4.3.1 Determining the volume of sludge (SV_{30}):

The sludge volume is equivalent to the volume of 1 litre of the activated sludge after a settling down period of 30 minutes.
The volume of sludge is a measure of the quantity of biologically active sludge. This value is an important parameter in the field of wastewater analysis, since the performance capability of the activation plant is controlled by the sludge volume.

For determining the volume of sludge (SV_{30}), the aeration of the activation tank must be active or it must be switched on in manual mode (valve 2).
As soon as the activation tank is well mixed, a sample of the activated sludge can be removed with the help of a bucket from the activation tank.
The sample withdrawn must be filled in a standing cylinder up to the 1,000 ml mark.

The sample filled in the standing cylinder must now be kept upright without any vibrations and protected from direct sunlight for 30 minutes.

Figure 9: Removal of a sample of the activated sludge for testing the proportion of sludge by volume

Figure 10: Filling a sample of the activated sludge in the standing cylinder

Figure 11: Sludge quantity at the beginning of the 30-minute standing time

Figure 12: Sludge volume after a standing time of 30 minutes

The volume of sludge is rounded off to 10 ml/l. If the volume of sludge is more than 250 ml/l, the measurement must be repeated after dilution.
For this purpose, the activated sludge sample is diluted with wastewater. The sample now diluted should have a sludge volume between 200 and 250 ml/l. The new measured value obtained must be multiplied with a dilution factor.

It is sufficient to make only one measurement to determine the sludge volume. This measurement reasonably reflects the volume of the sludge in the activation tank of the SBR plant. This is why we recommend to dilute the sludge sample and to repeat the measurement if the sludge volume is more than 250 ml/l.
However, after 30 minutes, if the sludge volume in the standing cylinder is more than 400 ml/l, the period of sludge recirculation must be increased. If the sludge volume is considerably below the 200 ml mark, the recirculation period may be reduced or disabled completely.

4.3.2 Assessment of the aeration pattern:

In order to assess the functionality of the wastewater aeration, the aeration and bubble pattern in the activation tank is observed while aeration is being done. Pay attention to the following characteristics:

- Moderate

→ Intensive, circulation is clearly identifiable

- Coarse bubbles

→ Fine bubbles

- One-sided

→ Moderate (if multiple membrane aerators have been installed in the tank)

4.3.3 Measuring the oxygen concentration

The oxygen content in the activation tank or the random sample is an important control parameter for wastewater treatment plants. The oxygen concentration is obtained with the help of measuring instruments, for which certain basic knowledge (calibration, maintenance, and storage) is required. The user manual of the measuring instrument must be studied for this purpose. The measured values are highly accurate when they are used properly.

Figure 13: Oxygen measuring instrument with the associated probe

Measurement in the sample container

Hold the measuring probe of the oxygen measuring instrument in the sample container and take a new measurement. The oxygen concentration should be at least 2 mg/l.
In case of substantial deviations, the aeration time of the controller must be adjusted (→ see the section „Setting optimal operational values“).
We recommend:

- O_2 < 2 mg/l

→ Increase the aeration

- O_2 = 2 to 6 mg/l

→ Do not modify the aeration

- O_2 > 6 mg/l

→ Reduce the aeration

You need to consider also the following:

- There may be fluctuations depending on the season. The dissolution behaviour of oxygen is better in cold weather than in warm weather. Hence, the measured values in winter are often somewhat higher than in summer.
- The oxygen concentration also depends on the quantity of the activated sludge (→ SV_{30}). If the quantity of activated sludge increases, more oxygen is consumed and the oxygen concentration comes down. This aspect must be kept in mind particularly in plants having seasonal fluctuations and when the time for sludge recirculation in the controller is modified.

Figure 14: Measurement of the oxygen concentration in the sample container

Measurement in the activation tank

The aeration of the activation tank remains switched on for the measurement of the oxygen concentration. The probe of the measuring instrument must now be immersed in the activation tank. The measuring instrument may be started now. It measures the content of oxygen dissolved in the wastewater automatically.

Figure 15: Immersed probe of the oxygen measuring instrument during aeration

Figure 16: Display unit of the oxygen measuring instrument

Since the SBR process in the activation tank for wastewater treatment or cleaning takes place in four different phases one after another chronologically (feeding, aeration, sedimentation and extraction), the oxygen concentration increases during the aeration phase. Before and after the aeration phase, that is, during the feeding, sedimentation and extraction phase, the oxygen concentration reduces, in contrast (see the following diagram for this purpose).

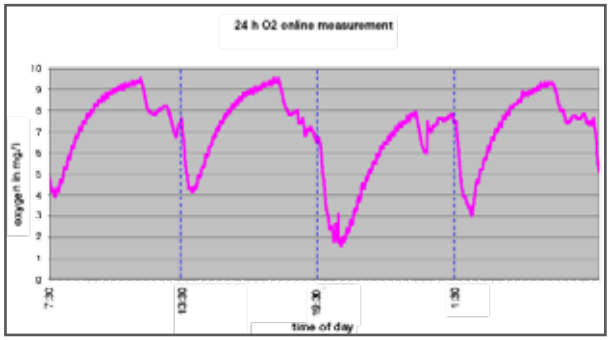


Figure 17: Typical trend of the oxygen concentration in the KLARO SBR chamber in the course of the day

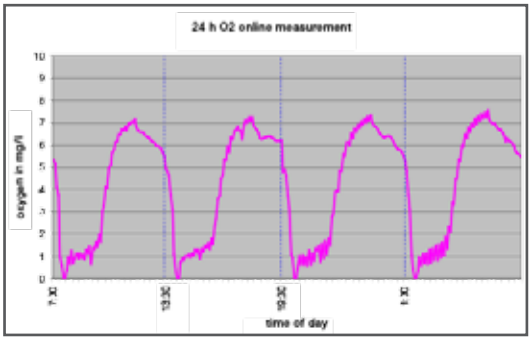


Figure 18: Typical trend of the oxygen concentration in the KLARO SBR chamber with additional denitrification during the day

In KLARO SBR-plant that have also been designed for denitrification, short bursts of aeration are used, prior to the actual aeration, to achieve circulation of the activation tank (the so-called pre-aeration phase). In the process, the denitrified microorganisms are stimulated to convert nitrate into its element, nitrogen. The oxygen concentration reduces considerably during the Deni-phase ($O_2 \approx 0$ mg/l). In order to ensure optimal denitrification, the oxygen concentration should not be more than 0.5 mg/l during the denitrification. Thus, the oxygen concentration in the activation tank of the wastewater treatment plant depends on the respective phase of the SBR process and a more accurate interpretation of the oxygen concentration measured - directly from the tank – is often very difficult. This is why we recommend that the oxygen concentration be determined in the sample container.

4.3.4 Simplified assessment of nitrification and denitrification

In order to quickly and easily assess the effectiveness of the nitrification/ denitrification, semi-qualitative test strips can be used as an aid. Here, a test strip (for ammonium or nitrate/ nitrite) is always dipped into the taken sample. Afterwards, the concentration contained in the sample can be compared on the basis of a colour scale. The more the test strip changes its colour, the higher is the concentration. In order to define the effectiveness of the nitrification (NH_4-N degradation), a sample is taken from the pre-clarification chamber/ sludge storage (first chamber) and an effluent sample from the outlet is taken from the sample container. The concentration of the sample from the pre-clarification chamber/ sludge storage should be approx. 50 mg/l and the concentration of the effluent sample from the outlet < 10 mg/l. If the concentration of the sample from the pre-clarification chamber/sludge storage is much higher than 50 mg/l, the inlet conditions must be examined.

	Pre-clarification / sludge storage	Effluent sample from the outlet	Result
Nitrification NH_4 content	ca. 50 mg/l	< 10 mg/l	good nitrification, O_2 content sufficiently
	ca. 50 mg/l	> 10 mg/l	poor nitrification
	> 50 mg/l	> 10 mg/l	poor nitrification
Denitrification NO_3 content	ca. 0 mg/l	< 50 mg/l	excellent denitrification
	ca. 0 mg/l	< 100 mg/l	good denitrification
	ca. 0 mg/l	> 100 mg/l	insufficient denitrification

Table 2: Evaluation of nitrification/denitrification test strips

Note: The result of the test strips is specified as NH_4 and/or NO_3. The threshold values are usually specified as NH_4-N and/or NO_3-N.

4.4 Sludge level measurement

The sludge level height in the pre-clarification / sludge storage has a direct impact on the cleaning or treatment performance of a wastewater treatment plant or septic tank. This is why it is indispensable to check the sludge level height. The level is measured with the help of a sludge dip-stick (acrylic glass tube).

For this purpose, you need to shift the layer of floating sludge to the side and dip the transparent sludge dip-stick with the open valve in the pre-clarification / sludge storage right up to the base of the tank. The valve is closed by pulling a control cable (provided with a ball valve) or with a forceful jerk (in case of a non-return valve), and the dip-stick may now be pulled out again.

Figure 19: Inserting the sludge pipette

Figure 20: Sludge level measurement with a sludge pipette

Figure 21: Sludge pipette in the storage pipe

The contents of the chamber are reproduced in the sludge pipette as a closed column. The sludge layer of the pre-clarification sludge storage can thus be read directly. To do this, the sludge layer - the solid constituents - must be clearly identifiable from the solid-free zone.
The sludge height is recorded in the report. It is required to arrange for proper disposal of the sludge from the pre-clarification sludge storage for proper operation. It is necessary to dispose of the sludge storage latest when 70% of the sludge storage is filled. The attention of the operator must be drawn to the need for disposal.
The sludge removed with the help of the sludge pipette must be emptied out again in the pre-clarification sludge storage. By immersing the pipette again in the aerated chamber, it becomes clean inside.
The sludge pipette, at best, must be stored in a PVC pipe after use for the sake of hygiene. The storage pipe is sealed at the bottom side with a stopper in order to trap any residual liquid.

Figure 22: Determining the sludge level height with a yardstick

4.5 Cleaning work

Finally, general cleaning work should be done within the plant:

- Removing deposits
- Clearing any clogging or jamming
- Replacing damaged installed components or kinked hose pipes
- Skim off the floating sludge on the activation chamber and put in the pre-clarification/sludge storage

5. Maintenance of the machines

5.1 Air filter

The filter for aerating the switch cabinet (aeration grate on the left and right side of the housing wall in the indoor cabinet or on the back side in the outdoor cabinet) must be checked and cleaned or replaced if necessary. To do this, the grate outside the cabinet must be removed. The clamp lock must be loosened by pressing lightly with a screwdriver and the grate must be pulled by hand. The filter mat lies in the ventilation shaft without any other fixture and may be shaken or blown off.

NOTE:

Clogged or choked filter mats impair the aeration and bleeding efficiency of the switch cabinet. Permanent consequences may include:

- Overheating in the cabinet (→ Temperature alarm of the controller gets triggered)
- Increased wear and tear of the electrical components, particularly the compressor and solenoid valves
- Reduced oxygen inlet by the compressor into the wastewater treatment plant

Figure 23: Removing the aeration grate

Figure 24: Checking the filter mat

5.2 Controller

5.2.1 Reading fault messages

You need to check the faults that have occurred since the time of the previous maintenance in the logbook of the controller. To do this, call up the following in the operator menu of the controller:

- „read out old errors“ (for KLplus and ZKplus)
- „Display errors or faults“ (for KLbasic and ZK)

This is where the latest message is displayed with the date and time. By pressing the or button, you can go to the previous messages.

NOTE:

There is a capacity to store 128 messages. If this number has been reached, every new message deletes the oldest one. The memory may be deleted by the maintenance technician in the service menu using the „clear logbook“ command.

5.2.2 Power-on hours

The total power-on hours of the loads (valves, compressors, …) as well as the utilisation (only for KLplus and ZKplus) must be read out and recorded.

To do this, call up the following in the operator menu of the controller:

- „operating hours meter reading“ (for KLplus and ZKplus)
- „operating hours report“ (for KLbasic and ZK)

The power-on hours of the compressor provide an indication of whether it is due for maintenance.
The „work load xx%“ (only in KLplus and ZKplus) provides the ratio of how many treatment cycles have actually been executed. A standard plant completes four cycles per day = 100%. The display primarily serves the purpose of plausibility check to see whether the function „level measuring“ has been set meaningfully.

5.2.3 Reading out data

Reading out data via cable and PC

The logbook of the controller may be read out on external storage media. There are the following options available at site for this purpose:
Reading out with cable + PC (all KLARO controllers)
To read out the logbook via cable, you need the following at site:

- PC (Laptop)
- Serial read cable, RS-232
- Possibly, USB - serial adapter
- Reading software KLARO@kom

To read out the data, the RS-232 connector of the cable connected to the socket on the back side of the controller. With the help of the KLARO@kom software, data is transmitted and transferred to preformatted Excel spreadsheets. These spreadsheets may be edited, saved and printed out, e.g. as an enclosure to a maintenance report.

Reading out with an SD card (only KLplus)

In order to read the data, the rubber stopper at the front of the controller is removed and an SD memory card is inserted into the free slot. In order to start the data transmission, you need to switch to the service menu to the „SD Card“ option and confirm with Set . As soon as the data has been transmitted completely, the display „SD Card OK“ appears. Now, by pressing Esc once again, you can exit from the service menu and remove the SD memory card. Finally, seal off the card slot in the controller carefully in order to prevent the ingress of moisture.
The data read out in the PC is transferred with the help of the KLARO@kom software from a PC to preformatted Excel spreadsheets. These spreadsheets may be edited, saved and printed out, e.g. as an enclosure to a maintenance report.

Figure 25: Reading out the data manually

Figure 26: Reading out data via cable and PC

Figure 27: Reading out data on SD card

5.2.4 Functional test

In the „Manual Mode“ menu, you can switch the loads on briefly and then again off to test all of them one after another. A malfunction in the electrical system is indicated by the controller as a fault. Proper working of the components should be checked visually in the wastewater treatment plant.

NOTES:

- **In the ZK and ZKplus controllers, the 9V battery is checked in parallel in the background.**
- **With the underloading detection activated in the KLplus and ZKplus controllers, the level is measured when valve 1 is in manual mode.**
- **As an alternative to switching the valves 1-4 manually, the option „operation test“ may be activated in the service menu. After a waiting period of two minutes, the controller automatically switches the valves 1-4 on for a few seconds and then again switches them off.**

Be careful when withdrawing an outlet sample! During the functional test for valve 3, the air lift generally transfers contaminated or water that has not settled adequately from the SBR chamber into the integrated sampling facility. Sampling for laboratory analyses is then no longer possible. Hence, always remove samples **PRIOR** to the functional test!

5.2.5 Setting optimal operational values

The controllers are preset with the loading embossed (PE number) and the class of treatment of cleaning. In the process, for the sake of safety, continuous maximum loading of the plant is assumed. The controller settings may be adjusted to the actual conditions at site. We recommend that such adjustments are made only after a safe start-up phase, for example, in the course of the first maintenance. In general, considerably lower running times may be achieved as a result. Control to lower levels should be done in small steps and recorded in the logbook or the maintenance report so that you can track the modification at the time of the next maintenance.

Typical adjustments are:

- Adjustments of the PE number or cleaning (treatment) class. The current values set are displayed in the „setup report“ menu, for example, „KLARO 8 EW C“. Any other table may be selected in the service menu and activated by pressing Set .

NOTES:

– **The new table selected is displayed in the „setup report“ menu only when the old cycle has ended or has been interrupted by the „restart the cycle“ function.**

- An overview of all controller tables is given in the enclosure or appendix. The controller has a capacity to hold maximum 25 tables or spreadsheets. Tables or spreadsheets may be copied with the help of KLARO@kom-Tool for special applications. Consult KLARO for this purpose.

- Adjustment of the aeration times in order to reduce or increase the entry of oxygen during the aeration phase, the clock cycle „Aeration ON T6“ and „Aeration OFF T7“ may be changed in the service menu under the option „duration period setup“.

NOTES:

– **When modifying a clock cycle time, always confirm with Set**

– **The modified cycle times are displayed in the „setup report“ menu only when the old cycle has ended or has been interrupted by the „restart the cycle“ function.**

– **KLbasic and KLplus display the current aeration period set currently in hours per day with T18. Modifications in the aeration times can be tracked easily here.**

– **The „Aeration phase T5“ remains untouched. Increasing it may lead to the maximum permissible total cycle time getting exceeded. This then leads to loss of the next cycle (the controller switches to „Cycle pause“) and to reduction in the total aeration period for the day.**

- Adjusting the number of cleaning or treatment cycles. In case of plants that are constantly underloaded (e.g. only one person at home), the number of cleaning or treatment cycles may be reduced from four cycles to two cycles. You can achieve this most easily by increasing the cycle time for the „Settlement phase T8“ from the default setting of „90 min.“ to „100 min.“. As a result, the maximum total cycle time permissible gets exceeded and only every second cycle gets executed. In between, the plant switches to the „Cycle pause“ status.

- Adjusting the sludge recirculation time. The period of the sludge recirculation may be reduced or increased via T12. In the ZK and ZKplus, this is done in steps of minutes. In the KLbasic and KLplus, this may be set to the nearest second. The sludge recirculation time should be changed by a maximum of one minute or 60 seconds.
- Adjusting the underloading feature (only in ZKplus and KLplus). The underloading feature serves primarily to conserve energy. The fill level, which leads to the commencement of a cleaning or treatment cycle, may be adjusted in the service menu under „Adjust fill level measurement“. The „work load“ in the „operating hours meter reading“ menu provides an indication of the actual ratio of the cleaning cycles to the pause cycles. Adjustment options:
  - Reduce „water level start at: xxx cm“ if: the loading level displayed is low, fill levels in the tanks, however are high and the discharge quality is unsatisfactory
  - Increase „water level start at: xxx cm“ if: the loading displayed is high, the fill levels in the tanks, however, is low, the discharge quality is good but the plant operator is dissatisfied with the energy conservation.

EXAMPLE:

Clock cycle	Function	ACTUAL value	Reduce	Increase
T 5	Aeration phase [min]	250	250	250
T 6	Aeration on [min]	4	3	5
T 7	Aeration off [min]	6	7	5

Table 3: Adjustment of ventilation times

5.3 Compressor

The maintenance work and intervals depend on the type of compressor.

5.3.1 „NITTO“ piston compressor

Detailed instructions on the operation and maintenance as well as drawings are given in the Operating Manual.
We recommend the following for maintenance:

- Checking the air filter with EVERY maintenance
- Replacing the piston set after 25,000 hours of operation

NOTES:

- **If the compressor is operated beyond the 25,000 hours of operation, the air compression capacity may get impaired. This must be compensated by increasing the aeration period. If tinkling or tapping noises can be heard, the piston set must be replaced immediately, otherwise the equipment may get damaged irreparably.**
- **There is a video clip available that demonstrates the maintenance of the compressor in an illustrative manner. You may send us a request for a copy free of charge.**

Figure 28: Opening the cover of NITTO compressors

Figure 29: Checking the air filter

Figure 30: Open housing for replacing the piston

Figure 31: Pistons

5.3.2 „BECKER“ or „RIETSCHLE“ rotary slide compressor

Detailed instructions on the operation and maintenance as well as drawings are given in the Operating Manual.
We recommend the following for maintenance:

- Checking the air filter with EVERY maintenance, but at least semi-annually
  - Omitted for the smaller design, BECKER DT 4.4 – 4.8
  - Blow off or replace contaminated air filters

NOTE:
A clogged or choked air filter leads to reduced air compression capacity and cooling of the equipment.

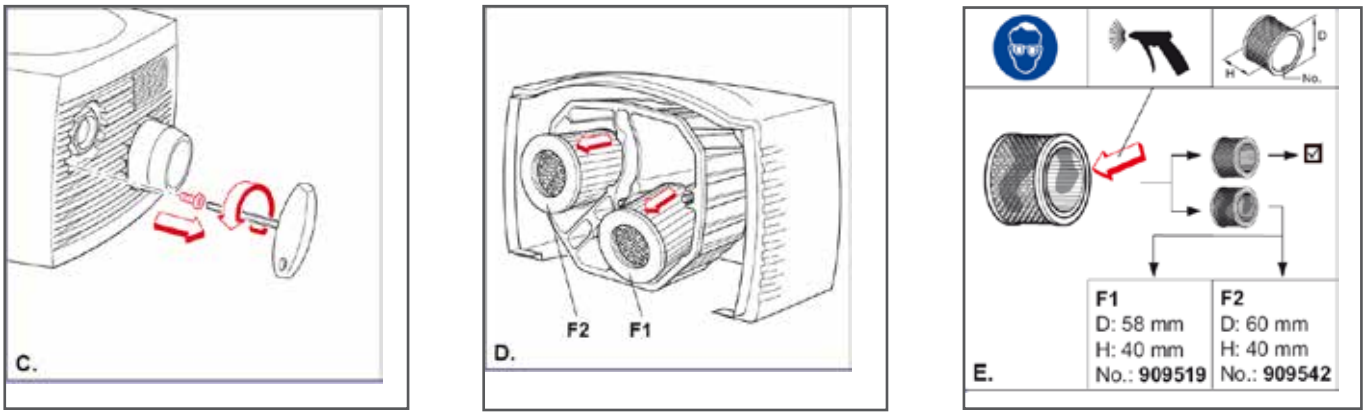


Figure 32: Checking the air filter

- Checking the slider width at least every 3,000 hours of operation.

– Record the slider width measured in the maintenance report in order to be able to track wear and tear and procure spare sliders in time.

NOTE:

If the slider width goes below the minimum permissible value, the rest of the slider may break and block the rotor.

- Checking the starting capacitor at least every 3,000 hours of operation.

– Disconnect the capacitor

– Use a multimeter (with capacitance measurement feature) with crocodile clips. For measuring leads having test tips, you should use a clamp (see figure) for assistance. Measurement directly on the terminal board will distort the result just as when you use your fingers to press the test tips on the leads of the capacitor.

– Target value [mF] is embossed on the nameplate of the compressor

NOTE:

The starting capacitor causes the compressor to run in the right direction when it is switched on. A worn (very weak) capacitor may start the compressor in the wrong direction (suction instead of compression).

Figure 33: Measuring the capacitance of the capacitor

Figure 34: Checking the slider

6. Troubleshooting

6.1 Poor purification performance

A poor purification performance along with a possible exceedance of limit values is an indicator of the small wastewater treatment plant either not working correctly or increased pollutant levels in the feed.
A properly planned and regularly maintained small wastewater treatment plant which is not subject to overloading generally exhibits very stable purification behaviour.
Malfunctions need to be expected if the measured values are not in the usual range of variation or are higher than the anticipated values. If limit values are exceeded, action must be taken.
Before considering operational or structural changes, the measured value must first be checked for plausibility. If increased levels are measured at the outlet of the small wastewater treatment plant, the first thing to be checked should be the execution of sampling. In the case of random samples, it must be ruled out that.

- the sample container contained residues of cleaning agents or another sample,
- too many solids are present in the sample due to contamination of the integrated sampling unit, the dipper or the sample container leading to distortion,
- a mix-up could be possible because of missing, inappropriate or incorrect identification of the sample container.

NOTE:
When taking samples by means of a dipper, it must be ensured that the dipper does not scratch the bottom during the scooping movement or the walls when inserting and removing the dipper.
If the results are implausible, a second measurement must be performed. If the increased outlet value measured is plausible and if there is no overloading of the small wastewater treatment plant, the cause of the present malfunction must be determined. When doing so, keep in mind that it does not always have to be a single cause which is responsible for elevated measured values. Increased outlet values may also be due to the combined effect of several causes.

6.1.1 Increased SS value

If the small wastewater treatment plant is adequately dimensioned and the bioreactor works smoothly, the SS value at the outlet should be about 10 mg/l. Consequently, an increased solids overflow only applies if the SS value exceeds 30 to 50 mg/l at the outlet.

The most common causes for an elevated SS value are:

- Full primary settlement chamber/ sludge storage,
- Increased solids concentration in the bioreactor (SV_{30} > 400 ml/l),
- Sludge bulking,
- Floc disintegration,
- Hydraulic overload.

Observation		Cause		Elimination
Increased SS value		Increased solids concentration in the bioreactor		Gradually increase excess sludge recirculation
		Sludge bulking		Increase oxygen supply
		Floc disintegration		Adjust pH by means of lime, soda or caustic soda. Check feed for inhibiting substances (disinfectants, medicaments, food residues, residues from renovation work: paint, paste, etc.)
		Hydraulic overload		Check the inlet volumes. Check built-in and electrical components (switch cabinet)
		Full primary settlement chamber		Arrange for desludging of the primary settlement chamber

Table 4: Elimination of increased SS values

6.1.2 Increased COD or BOD_5 value

In new small wastewater treatment plants, it generally takes some time for the activated sludge required for biological purification to form. Up until this moment, the purification performance will not yet reach its full potential.

Moreover, an increased COD or BOD_5 value at the outlet is due to both particulate and dissolved substances. For example, depending on the organic content, 1 mg/l solids has a COD value of 0.8 – 1.6 mg/l.

As with the increased SS value, this may have several reasons. The most common causes include, for example:

- Increased solids concentration,
- Sludge bulking,
- Floc disintegration,
- Hydraulic overload,
- Incorrect or insufficient aeration.

An increased solids concentration in the bioreactor may reduce the sedimentation effect. Clear water can no longer sufficiently separate from the sludge floc which results in sludge overflow. An efficient means to counteract solids overflow is an increased excess sludge recirculation. However, the excess sludge recirculation should only be increased gradually.

A poorly settleable and easily floating sludge structure (bulking sludge) may also lead to an increased COD or BOD_5 value. Bulking sludge refers to excessive growth of filamentous microorganisms. In contrast to floc-forming microorganisms, they exhibit poorer settling properties and are discharged from the small wastewater treatment plant together with the clear water. In most cases, sludge bulking is due to an insufficient oxygen supply or an insufficient mixing within the bioreactor. Reduced oxygen conditions stimulate the growth of filament formers. Therefore, the oxygen supply should be checked and increased if necessary.

In addition to filamentous microorganisms, the augmented disintegration of sludge floc may result in an increased sludge overflow and thus increased outlet values. Floc integration is usually caused by:

- The destruction of the structural substance of the sludge floc due to the pH in the bioreactor being too low or too high,
- Inhibiting substances in the wastewater treatment plant feed,
- Salt impacts in the wastewater treatment plant feed.

For this reason, the pH must always also be determined. If the pH is below 6.5 or above 9.0, this usually results in floc disintegration and an inhibition of purification performance. In order to stabilise the pH, chemical additives (alkalis) must be added to the bioreactor in such an amount and until the pH is set to a range of 6.5–8.0. For cost reasons, the addition of lime is recommended.

A hydraulic overload may result in an increased input of solids from the primary settlement chamber into the bioreactor. The bioreactor is then overloaded with increased pollutant levels.

Moreover, an increased input of solids into the bioreactor is also caused by a full primary settlement chamber. In such a case, sludge disposal should be arranged for.

Observation		Cause		Elimination
Increased COD or BOD_5 value		Increased solids concentration in the bioreactor		Gradually increase excess sludge recirculation
		Sludge bulking		Increase oxygen supply
		Floc disintegration		Adjust pH by means of lime, soda or caustic soda. Check feed for inhibiting substances (disinfectants, medicaments, food residues, residues from renovation work: paint, paste, etc.)
		Hydraulic overload		Check the inlet volumes. Check built-in and electrical components (switch cabinet)
		Incorrect or insufficient aeration		Check aeration intervals and readjust if necessary
		Full primary settlement chamber		Arrange for the desludging of the primary settlement chamber
		High proportion of substances with poor degradability or that do not degrade at all		Informing the operator about problematic substances
		Humic materials		--

Table 5: Elimination of increased COD or BOD_5 values

6.1.3 Increased NH_4-N value

In small wastewater treatment plants with additional nitrification, the inorganic nitrogen compound ammonium (NH_4+) of the raw wastewater is oxidised into nitrate (NO_3-). This transformation requires a large amount of oxygen. In order to measure the nitrogen balance, ammonia nitrogen (NH_4-N) is used. If the ammonium content at the outlet is elevated, possible causes generally include a reduced activated sludge performance and insufficient aeration. It must be kept in mind that the nitrification performance depends on the temperature in the bioreactor. If the water temperature inside the bioreactor falls below 10°C, the nitrification performance is inhibited.

When eliminating faults with the nitrification, the oxygen content should be checked first. If the oxygen content at the outlet is less than 2 mg/l, this represents an insufficient oxygen concentration. Defective devices such as disc aerators, hoses and compressors are possible causes for an insufficient oxygen concentration.

NOTE:

Increased NH_4-N values at the outlet at water temperatures of below 10°C do therefore not represent a malfunction. The same applies to previous temperature fluctuations even if the current water temperatures are within the range greater than 12°C.

Observation		Cause		Elimination
Increased NH_4-N value		Insufficient oxygenation		Increasing the aeration
		Aerobic sludge age too low		Temporarily switch off the sludge recirculation.
		Water temperature below 10°C		--
		pH - value is too low (<6.5 > 9) or too high		Readjust the pH value by using lime, soda or soda lye.

Table 6: Elimination of increased ammonia nitrogen values

6.1.4 Increased N_{tot} value

During denitrification, nitrate is transformed into elemental nitrogen (N_2) via nitrite under anoxic conditions (oxygen-free phase). Most bacteria contained in the activated sludge are capable of this process. For an effective denitrification, both sufficient organic carbon and nitrate are needed. If a high concentration of ammonium or nitrate is measured at the outlet, this is indicative of insufficient nitrogen degradation.

An improper excess sludge recirculation which heavily reduces the sludge content in the bioreactor does not only impair nitrification performance but also denitrification performance.

The oxygen input is of critical importance for the denitrification performance. An excess oxygen supply has an inhibiting effect on the denitrifying bacteria.

In addition, there must be a sufficient contact between the wastewater and the denitrifying bacteria. On the one hand, this is ensured by means of a complete mixing inside the bioreactor through short aeration periods and, on the other hand, by means of a 30-minute contact time. A sufficiently long contact time is required as denitrification does not begin immediately but only after the dissolved oxygen has been used up by the bacteria.

If the anoxic phase is too short and if the mixing inside the bioreactor is insufficient, the nitrate will only be denitrified incompletely.

If denitrification is impaired by the contact time being too short or an unfavourable arrangement of the cycle starting times, the denitrification period and the cycles must be readjusted.

Observation		Cause		Elimination
Increased N_{tot} value		Increased oxygenation during the denitrification phase		Extending the denitrification phase
		Insufficient nitrification		Improving the nitrification performance by raising the oxygen content in the ventilation phase
		Contact time too short		Extending the mixing process
		Amount of activated sludge too low		Shortening or temporarily switching off the excess sludge removal
		Water temperature below 10°C		--

Table 7: Elimination of increased total nitrogen values

6.1.5 Increased P_{tot} value

Thanks to the addition of a precipitant, the dissolved phosphates contained in the wastewater are transformed to an undissolved form and can thus be separated.
Possible precipitants primarily include iron compounds (iron chloride, iron sulfate, iron chloride sulfate) or aluminium compounds (poly-aluminium chloride, aluminium chloride, sodium aluminate, aluminium sulfate).
The precipitation performance significantly depends on the dosage, the pH and the precipitation conditions.
Possible causes for increased P_{tot} values at the outlet are:

- Underdosage of precipitant,
- Empty precipitant canister,
- Defective dosing pump,
- Disruption of the supply flow,
- Dysfunction regarding the uptake of chemicals into the hose,
- Leaking dosing line,
- External impact loads.

In case of a malfunction regarding phosphate precipitation, the overall dosing mechanism (dosing pump, precipitant canister, hoses) must be checked first. For this purpose, the dosing of the precipitant is to be activated manually and the dosing point is to be checked. The dosing point for the precipitant is exposed inside the small wastewater treatment plant and is therefore visible from the outside.
An underdosage of precipitant can be rectified through an increase (in the case of pumps with potentiometers) or an extension of the pumping duration.
If the precipitant canister contains a sufficient amount of precipitant and the dosing pump runs properly, possible causes for an insufficient phosphate precipitation include the disruption of the liquid flow or a dysfunction regarding the uptake of chemicals into the hose.
The supply flow may be disrupted if air instead of precipitant is sucked into the hose. This is caused by the hose having been incorrectly inserted into the precipitant canister.

Figure 35: P-module in the concrete cabinet

NOTE:
If the hose is attached to a pipe or rod and inserted vertically into the canister down to its bottom, the hose can no longer curl up inside the precipitant canister and suck in air.

In addition, clogging of the lines may also block the uptake of chemicals. Clogging is usually due to the following causes:

- Incrustation in the canister,
- Crystallisation of the solution because of low temperatures.

In such cases, the clogging must be removed and the precipitant must be replaced.
In addition, the precipitant flow may be prevented by defects in the dosing line causing the precipitant to no longer be pumped up to the small wastewater treatment plant. The line must be checked for leaks. If the dosing line is leaking or broken, discharge into the soil must be prevented.

External impact loads resulting in an increase of phosphate compounds must be discussed with the operator of the small wastewater treatment plant. Elevated phosphorous loads are usually due to the introduction of food residues.

Observation		Cause		Elimination
Increased P_{tot} value		Underdosage of precipitant		Increase or extension of dosing amount/duration
		Empty precipitant canister		Refill with new precipitant
		Defective dosing pump		Replacement of the defective pump with a new dosing pump
		Disruption of the supply flow		Correct insertion of the dosing hose into the precipitant canister In addition: attachment of the hose to pipe/rod

Increased P_{tot} value		Dysfunction regarding the uptake of chemicals into the hose (incrustation, crystallisation)		Removal of clogging Replacement of the crystallised precipitant
		Leaking dosing line		Replacement of the dosing line
		External impact loads with phosphorous compounds		Avoiding the introduction of food residues

Table 8: Elimination of increased P_{tot} values

6.1.6 Increased / decreased pH value

An increased or decreased pH-value is mostly due to external factors.

As an example, a pH of more than 8.5 is a detectable indicator for the introduction of alkaline substances (cleaning agents for the removal of fats and oils). The risk posed to bacteria and thus the risk of an insufficient purification performance of the small wastewater treatment plant increases with the amount, duration and lye concentration of the introduced substances. Even though the wastewater in the small wastewater treatment plant has a certain buffering effect causing the alkalis to be essentially neutralised and preventing damage to the biological components, a pH of more than 9.0 due to the alkalis introduced may inhibit or destroy the bacteria in the bioreactor. Moreover, in combination with elevated wastewater temperatures, a high pH result in the formation of ammonia (NH_3). Ammonia has a strong inhibiting effect on nitrification. If the alkalis are already present in the activation (bioreactor), it is only possible to take measures which limit the potential consequences for the purification performance.

The following measures are recommended against an increased pH:

- Intensified aeration (maximum possible oxygen supply),
- Addition of iron and aluminium salts (PAC) in order to neutralise the alkalis, and
- Monitoring further pH development.

If the pH falls below 6.5, this may be due to the introduction of acidic substances. The risk posed to the purification performance rises with an increasing amount and acidity of the substance. When introducing acidic substances into the bioreactor, the inhibition or destruction (floc disintegration) of the biological components cannot be ruled out. In addition, there is an increased risk of corrosion for built-in components.

The following measures are recommended for controlling a decreased pH:

- Addition of alkaline neutralisers (calcium hydroxide, soda, caustic soda)

Observation		Cause		Elimination
Increased pH		Introduction of alkaline substances		Intensified aeration
				Addition of iron and aluminium salts (PAC)
Decreased pH		Introduction of acidic substances		Addition of alkaline neutralisers (calcium hydroxide, soda, caustic soda)

Table 9: Elimination of increased/decreased pH-values

6.2 Bulking sludge

If bulking sludge – activated sludge with very poor settling properties – is present, the activated sludge "stands" in the bioreactor without settling properly during the sedimentation phase. This results in a very high risk of sludge overflow. When determining the sludge volume SV_{30} under such conditions, there is no compact sludge structure at the bottom of the measuring cylinder even after a settling time of 30 minutes. The sludge floc is of light brown colour and appears very voluminous.

Bulking sludge is caused by about 30 different filamentous bacteria which are most readily identified by means of a microscope.

The increased growth of filamentous bacteria is due to wastewater-related, plant-related and operational causes.

- Wastewater-related causes:
  - Nutrient deficiency (nitrogen/ phosphorous)
  - Septic wastewater (hydrogen sulphide)
  - Extreme pH-values
- Plant-related causes:
  - Long sludge storage times (digestion)
  - Poor mixing
- Operational reasons:
  - Insufficient aeration (low oxygen supply)

Prior to taking measures against sludge bulking, keep in mind that bulking sludge mainly occurs in transition periods (autumn/winter and spring/summer). In such transition periods, the overall biocoenosis of the activated sludge is subject to more intense changes due to temperature fluctuations. The filamentous bacteria are less sensitive to such changes and propagate more intensively during this time. Meanwhile, the activated sludge is bulking but still exhibits a good performance. If the purification performance is not yet impaired by the overflowing sludge, it is not necessarily required to take intensive countermeasures.

For controlling excessive sludge bulking, several measures are possible:

- Removal of deposits from the sewer system and the plant which result in the wastewater becoming septic,
- Increase of the oxygen supply by intensifying aeration intervals,
- Increase of the excess sludge discharge,
- Addition of calcium hydroxide, iron or aluminium salts in order to weigh down the activated sludge,
- External nutrient addition when detecting nutrient deficiency in the plant's feed

Observation		Cause		Elimination
Increased sludge bulking		Septic wastewater		Removal of all deposits from the sewer system and the plant
		Extreme pH-values		Adjust pH by means of lime, soda or caustic soda. Check feed for inhibiting substances (disinfectants, medicaments, food residues, residues from renovation work: paint, paste, etc.).
		Nutrient deficiency		Check the nitrogen and phosphorous concentration in the feed. In case of a deficiency, external addition of nutrients
		Incorrect or insufficient aeration		Check aeration intervals and readjust if necessary
		Long sludge storage times		Arrange for draining of the primary settlement chamber

Table 10: Control of bulking sludge

6.3 Floating sludge and foam

A dysfunction similar to sludge bulking is the formation of floating sludge and foam inside the bioreactor.

The formation of floating sludge and foam is characterised by:

- A large, compact floating sludge layer, and
- Brown, greasy foam.

Moreover, the foam cannot be removed by means of hosing.

In most cases, the process is not impaired by foam formation. The process quality is only influenced if the foam flakes reach the sampling unit or directly enter the outlet.

The formation of floating sludge/foam is mainly an operational and aesthetic problem which leads to an increased effort when it comes to removal work. Like sludge bulking, the formation of floating sludge / foam occurs in seasonal transition periods (spring/ summer and autumn/winter).

The formation of floating sludge and foam preferably occurs if an increased amount of longchain fatty acids is formed in the wastewater.

Long-chain fatty acids are degradation products from fats and surfactants (detergents).

In addition, they are created due to septic wastewater in the preliminary settlement chamber or with sludge deposits. Foamforming bacteria especially form in so-called stagnation zones due to insufficient mixing. As soon as the effects of an insufficient oxygen supply creating a growth advantage for filamentous bacteria and septic water enabling the formation of fatty acids combine, floating sludge and foam are formed.

A targeted elimination of floating sludge/foam formation is only possible to a limited extent.

The measures:

- Hosing, and
- Discharge into the preliminary settlement chamber

can only be successful for a short time. In contrast, it is efficient to remove the floating sludge layer from the small wastewater treatment plant.

In addition, the excess sludge discharge should be increased temporarily in order to reduce the sludge age inside the bioreactor (lower solids content in the bioreactor). Since the nitrification performance of the bioreactor is reduced, this measure should only be used for plants requiring nitrification if this is absolutely necessary.

NOTE:

Foam is also formed in the bioreactor during the break-in period. However, this is due to the growth of biomass. The foam is light beige in colour, degrades very quickly and does not represent a malfunction.

Observation		Cause		Elimination
Floating sludge and form formation in the bioreactor		Septic wastewater		Draining of the preliminary settlement chamber / sludge storage
		Impact loads with surfactants and fats		Change of the inlet water: • Less washing machine cycles per day • Changeover to bio-degradable detergents and cleaning agents • Reduced use of fat and oil in the kitchen
		Incorrect or insufficient aeration		Check aeration intervals and readjust if necessary
		High sludge age		Increase excess sludge discharge

Table 11: Elimination of floating sludge and foam

6.4 Smells

As with municipal wastewater treatment plants, the operation of a small wastewater treatment plant is not completely free of smells. If the venting of the small wastewater treatment plant is intact, no smells are detectable while the plant is in its closed condition. Only if ventilation is insufficient, smells may escape from the small wastewater treatment plant.

6.4.1 Smell of gas

In the event of a detectable smell of gas and possible streaks in the wastewater, it is likely that readily combustible gases and/or liquids have entered the small wastewater treatment plant. There is an acute risk of explosion and fire.

The following immediate measures must be taken:

- Electrical equipment in the area of the small wastewater treatment plant must be switched off. The equipment must be switched off via the main switch or by remote control.
- The airlift pumps (feed, clear water and excess sludge lift) must be adjusted.
- The feed situation must be checked.

6.4.2 Smell of ammonia

If a smell of ammonia is detected, this may indicate an increased feed of ammonium compounds.

In addition to increased outlet values, the oxygen consumption in the bioreactor is higher. The feed must be inspected for possible sources of wastewaters containing ammonium (liquid manure, etc.).

6.4.3 Smell of rotten eggs

If there is a smell of rotten eggs, the feed contains an increased amount of sulphurous substances. Deposits in the pipes leading to the small wastewater treatment plant cause the formation of hydrogen sulphide (H_2S).

The H_2S contained in the plant can be converted by means of $FeCl_3$.

7. Maintenance report

Location (address): _____

Maintenance Company: _____ Date of maintenance: _____

Serial number: _____ Order no.: _____

Plant size: _____ Actual connection: _____

Operator's name: _____ Street: _____

Postcode / City: _____ Tel.no.: _____

Is industrial wastewater also introducted? ☐ No

☐ Restaurant without a kitchen ☐ Restaurant with a kitchen ☐ Others

☐ Grease separator available, NG ☐ Emptying necessary

1. Visual impression (structural condition of the filled plant):

The system is accessible	☐ Yes	☐ No	_____
The manhole cover is in good connection	☐ Yes	☐ No	_____
Feed pipes and drain pipes are free	☐ Yes	☐ No	_____
Installed components OK	☐ Yes	☐ No	_____
Water levels OK	☐ Yes	☐ No	_____
Aeration tank has no floating sludge	☐ Yes	☐ No	_____
No foam formation	☐ Yes	☐ No	_____
No grease deposits	☐ Yes	☐ No	_____
Aeration and bleeding OK	☐ Yes	☐ No	_____
Partitions OK	☐ Yes	☐ No	_____
Corrosion damage	☐ Yes	☐ No	_____
The plant is not leak-proof externally	☐ Yes	☐ No	_____

Remarks: _____

2. Analysis of wastewater and sludge (Sampling):

Sampling time: _____ Hours Air temp.: _____ °C

Sampling point: ☐ Sample container ☐ SBR chamber ☐

Sample transport: ☐ cooled to 4°C ☐ frozen ☐

Odour:	☐	None	☐	weak	☐	strong	☐	foul	☐ earthy
Coloration:	☐	None	☐	weak	☐	strong	☐	beige	☐ brown
Turbidity:	☐	None	☐	weak	☐	strong	☐	opaque	
Floating substances:	☐	None	☐	low	☐	plenty			

SS_{120}: _____ mg / l Water temp.: _____ °C

BOD_5: _____ mg / l pH-value: _____

COD: _____ mg / l SS: _____ mg / l

NH_4-N: _____ mg / l N_{total}: _____ mg / l

3. SBR Reactor

Proportion of sludge by volume: _____ ml/l (maximum 400 ml/l)

Oxygen concentration: _____ mg/l (normal about 4-6 mg/l ; at least 2 mg/l)

Air intake / Aeration: ☐ moderate ☐ intensive, circulation is clearly identifiable

Aeration pattern / Aeration: ☐ fine bubbles ☐ uniform

Remarks: _____

4. Pre-clarification / Sludge storage + buffer:

Sludge height: _____ cm Floating sludge height: _____ cm

☐ The operator should arrange for emptying out the septic tank

Remarks: _____

5. Maintenance of the machines:

Air filter:

☐ Air filter cleaned ☐ Air filter replaced

Controller:

☐ Faults have been read

Remarks: _____

Controller type: _____ Total power-on hours: _____

Charging (Valve 1): _____ Discharge (Valve 3): _____

Aeration (Valve 2): _____ Recirculation (Valve 4): _____

UV reactor: _____ Replace the lamp after power on hours: _____

Remarks: _____

☐ Data has been read

☐ Functional test / check performed

☐ Charging air lift / Valve 1 (red) ☐ Aeration / Valve 2 (blue)

☐ Discharging air lift / Valve 3 (black) ☐ Excess sludge air lift / Valve 4 (white)

Remarks: _____

Compressor: Compressor type: _____

☐ Compressor OK ☐ Condenser OK

☐ Checking the blades (Width of the blades: _____ mm) ☐ Replacing the diaphragms

☐ Replacing the filter ☐ Cooling fan OK

Remarks: _____

6. Supplementary Remarks:

☐ Logbook is available ☐ Maintenance has been recorded in the logbook

☐ Programming has been changed: _____

☐ The fault has been rectified: _____

Supplementary Remarks: _____

7. To be initiated by the operator:

☐ The operator is requested to pay attention to the materials not to be fed (see logbook).

☐ The tank is jammed and the operator must ensure discharge.

☐ Shut down the tank (arrange for disposal of the sludge storage).

_____

Date and signature

8. Wastewater parameters

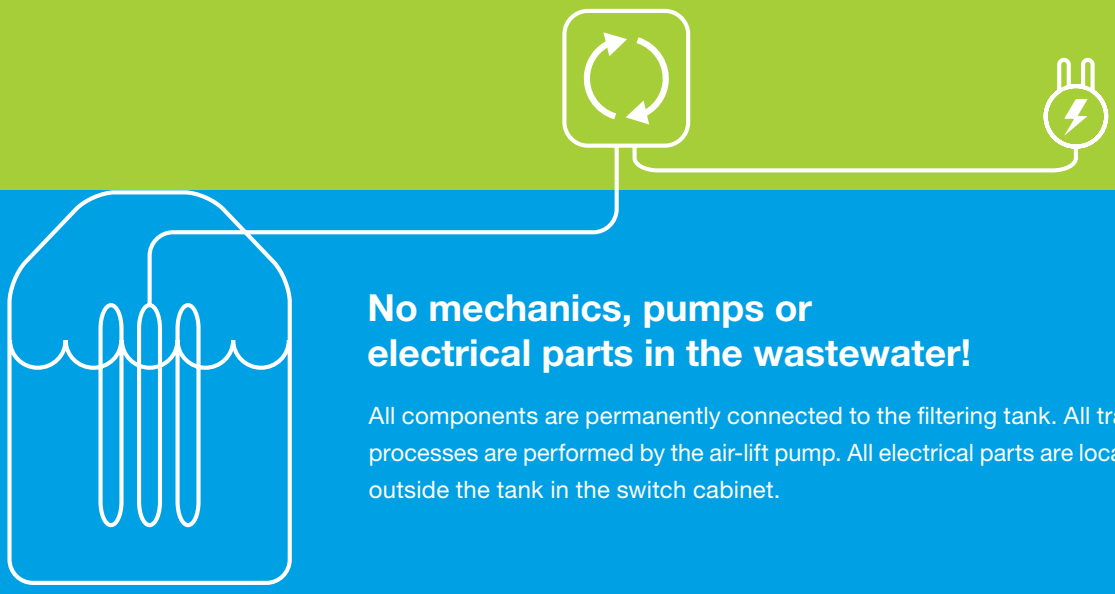
Wastewater parameters	Explanation	Limit values	Feed and discharge	
			Raw wastewater	KLARO process values
BOD_5 [mg/l] Biochemical oxygen demand	Measure for the total of the biologically decomposable wastewater constituents. BOD_5 indicates the amount of oxygen that is need for the biological decomposition of organic substances in a period of five days.	20 - 40	150 - 500	5 - 9
COD [mg/l] Chemical oxygen demand	Measure for the total of all organic wastewater constituents, including those that are difficult to decompose. COD indicates the amount of oxygen that is necessary for complete oxidation of organic wastewater constituents. Parameters for the degree of contamination	90 - 150	300 - 1000	39 - 48
SS [mg/l] Suspended solids	Measure for the totality of the undissolved wastewater constituents that are removed by filtration. In raw wastewater, the undissolved substances make up about 1/3 of the contamination.	30 - 75	200 - 700	5 - 15
NH_4-N [mg/l] Nitrogen-Ammonium	Measure for the oxidative decomposition of nitrogenous compounds by nitrifying bacteria (nitrification). Proportion of nitrogen in the wastewater in the form of ammonium.	10 - 20	22 - 80	0,8 - 7
N_{total} [mg/l] Total nitrogen	Measure for the efficiency of the nitrogen decomposition (nitrification and denitrification). Total of the organic and inorganic nitrogenous substances in the wastewater.	25 -	25 - 100	16 - 20
P_{total} [mg/l] Total phosphorous	Measure for the pollution of raw wastewater with phosphorous compounds. The elimination of P_{total} takes place to a large extent via the P precipitation.	1 - 5	5 - 20	0,4 - 3
SS_{120} [ml/l] Settleable solids	Measure for the totality of the water constituents that settle down within two hours. The substances that settle down make up about 1/4 of the total wastewater constituents.	-	1 - 20	< 0,1 - 0,3

pH-value [-]	Measure of the hydrogen ion concentration and thus, for the acidity of the wastewater. The lower the pH-value, the more acidic is the wastewater. The efficiency of the bacteria to be decomposed depends on the pH-value (Optimum: 6,5 – 8,0).	-	7,2 - 8,2	6,5 - 8,0
O_2 [mg/l] Oxygen concentration	Measure of the concentration of dissolved oxygen in the wastewater. The oxygen is essential for the aerobic treatment of wastewater. Impurities in the water (wastewater) lead to great wastage of oxygen. Hence, the oxygen concentration of raw wastewater is equal to zero.	-	0	>= 2

Table 12: Wastewater parameters

This Maintenance Manual of KLARO is just a recommendation and is not entitled to completeness.

The KLARO principle
Maximum operating reliability!



No mechanics, pumps or electrical parts in the wastewater!

All components are permanently connected to the filtering tank. All transportation processes are performed by the air-lift pump. All electrical parts are located securely outside the tank in the switch cabinet.

Our benefits

- Almost all possible approvals
- Extremely short delivery times thanks to optimised production
- Legal threshold values undercut by up to 90%
- 98% treatment performance in 6 hours
- TÜV-tested switch cabinets (EPP, indoor switch cabinet, outdoor switch cabinet)
- Certified underload detection
- Fully-biological mode of operation
- Quality products, with extremely high customer satisfaction levels
- Minimal power consumption
- All transportation processes performed by air-lift pump
- Treat water and introduce it back into the natural cycle
- Only one tank required for systems of up to 20 PE (Personnel Equivalent)
- Suitable for retrofitting to practically any tank shape
- Retrofitting possible in single, twin, triple and multi-chamber pits
- Installation possible in any type of tank, from plastic to fibreglass to concrete

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